

Global web accessibility assessment of national libraries' websites: A 2025 snapshot

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journals.sagepub.com/home/lis**Pastor Nso-Mangue¹** and **Sergio Luján-Mora¹**

Abstract

The Web has become a critical asset in the information society. Therefore, it is essential that everyone, including persons with disabilities, has equal access to the Web. But library websites still present barriers to persons with disabilities. Fortunately, the World Wide Web Consortium (W3C) has developed the Web Content Accessibility Guidelines (WCAG) that websites should conform with. Also, some countries have established regulations to force organizations to have their websites accessible by applying WCAG. Despite these efforts, the accessibility of national library (NL) websites remains a global concern. Therefore, it is important to raise awareness among all potential stakeholders of NLs about the prevalence of web accessibility barriers. This study aims to perform a web accessibility evaluation of NLs worldwide and also explores the availability of web accessibility information on NL items from Wikidata. For that, a group of selected websites is evaluated by using Pope Tech web accessibility evaluation platform. Pope Tech can scan, identify, and report issues on a group of websites in asynchronous mode. The findings indicate that most of the NL websites evaluated do not comply with WCAG 2.2, and substantial improvements are needed. Also, we found that information about web accessibility was missing on Wikidata items of NLs. To address this gap, we enriched the NL items in Wikidata by creating accessibility statements and associated qualifiers. Finally, we created a section about web accessibility on the English version of Wikipedia pages of NLs, in the hope that it will raise awareness among stakeholders.

Keywords

national libraries, persons with disabilities, web accessibility evaluation, Wikidata, Wikipedia

Introduction

The Web has an accessibility crisis, and it runs deep (AudioEye, 2025). Most of the websites are not accessible by persons with disabilities and the situation is far from improving (Utah State University, 2026).

National libraries (NLs; Wikimedia Foundation, 2025a), which have been a source of bibliographic information for the general public and scientists for generations, are also affected by this web accessibility crisis. Nowadays, NLs have web portals through which the public can interact remotely. However, people with disabilities, who make up around 16% of the global population (World Health Organization, 2023), still face barriers that prevent them from accessing NL websites.

The World Wide Web Consortium (1999) has set out the Web Content Accessibility Guidelines (WCAG) that websites should conform with in order to be accessible to everyone. However, there are still websites that do not

implement WCAG (Utah State University, 2026). The conformance of NL websites against WCAG standard can be done manually or automatically by using automated web accessibility evaluation tools (AWAETs). Evaluation through AWAETs can be done in two ways: quantitatively or qualitatively (Durdu and Soydemir, 2022).

The International Federation of Library Associations and Institutions (IFLA; 2026) has also created guidelines to make libraries accessible to persons with disabilities. Nevertheless, some NL websites remain inaccessible for persons with disabilities.

¹Universidad de Alicante, Spain

Corresponding author:

Pastor Nso-Mangue, Departamento de Lenguajes y Sistemas Informáticos, Universidad de Alicante, Carr. de San Vicente del Raspeig, s/n, Alicante 03690, Spain.
Email: pnm19@alu.ua.es

The web accessibility of NL websites (Irvall and Skat Nielsen, 2005) is a topic that has undergone intensive research using a variety of evaluation methods (Galkute et al., 2020; Jilani et al., 2026; Liu et al., 2024; Panda and Kaur, 2022). However, organizations are slow to adopt web accessibility guidelines, even though many countries have ratified the United Nations Convention on the Rights of Persons with Disabilities (CRPD; United Nations, 2006). Therefore, to reach a worldwide enforcement of web accessibility, there is a need for continuous awareness from researchers.

The main objective of this study is to explore the status of conformance of NL websites against WCAG 2.2. Also, this study explores the availability of web accessibility information on Wikidata items of NLs. Wikidata is one of the largest databases in the world. It is also the database that powers Wikipedia (Wikimedia Foundation, 2026). Therefore, having web accessibility information on Wikidata and Wikipedia may increase the awareness about web accessibility compliance by reaching a wider range of potential stakeholders (Similarweb, 2025).

Background

Web accessibility

A website is accessible when it can be used by everyone, including persons with disabilities. Various sets of accessibility guidelines have been proposed to help creating accessible websites, but WCAG (World Wide Web Consortium, 1999) has become a de facto standard and is developed by the W3C since 1999. WCAG has evolved over time to adapt to the changes of the Web:

- WCAG 1.0 was released in 1999 (World Wide Web Consortium, 1999).
- WCAG 2.0 was released in 2008 (World Wide Web Consortium, 2008). In 2012, it was adopted as an international standard under ISO/IEC 40500:2012 (International Organization for Standardization, 2012).
- WCAG 2.1 was released in 2018 (World Wide Web Consortium, 2018).
- WCAG 2.2 was released in 2023 (World Wide Web Consortium, 2024b) and has replaced WCAG 2.0 as the new ISO standard of web accessibility as ISO/IEC 40500:2025 (International Organization for Standardization, 2025).
- WCAG 3.0 is the current draft (World Wide Web Consortium, 2026) and introduces some changes to the structure, conformance model and scope compared to WCAG 2.0.

WCAG 2.0 was an improvement on WCAG 1.0, based on principles rather than checkpoints (World Wide Web

Consortium, 2024a). The WCAG 2.0 and subsequent updates comprise a set of guidance layers that include four principles, general guidelines, testable success criteria, and a rich collection of sufficient and advisory techniques. The four principles of WCAG 2.x (World Wide Web Consortium, 2024a) are:

- **Perceivable.** Users must be able to perceive information and user interfaces.
- **Operable:** Users must be able to operate the user interface.
- **Understandable:** Users must be able to understand the information and how to operate the user interface.
- **Robust:** Users must be able to access the content using a wide variety of user agents, including assistive technologies, as well as any new technologies that emerge.

One of the important aspects that determine accessibility of a website is the number of Accessible Rich Internet Applications (ARIA) elements that it contains. ARIA standards (World Wide Web Consortium, 2023b) are related to the principle of robustness and enables better interaction between the webpage and assistive technologies for persons with disabilities.

Each of the four principles of WCAG 2.x (World Wide Web Consortium, 2024a) is associated with a list of guidelines that addresses the corresponding principle, and under each guideline there are success criteria that describe specifically what must be achieved to conform with WCAG. Each success criteria is linked to sufficient or advisory techniques:

- **Sufficient techniques:** These are techniques that, when applied to web content, guarantee that it meets the success criteria. However, not applying them does not necessarily mean that the web content will not meet the success criteria.
- **Advisory techniques:** These are techniques that are recommended to improve accessibility when implemented in web content. However, they may not meet the success criteria requirements, and in some cases they may not be testable.
- **Failures:** These are things that cause accessibility barriers, fail specific success criteria, and help web developers identify what to avoid.

In order to meet the needs of different groups of people with different needs, web content should fulfill the following WCAG 2.x conformance levels (World Wide Web Consortium, 2023a):

- **Level A conformance,** which is the lowest level: The web content that satisfies all the Level A success criteria.

- Level AA conformance: The web content satisfies all Level A and Level AA success criteria.
- Level AAA conformance is the highest level: The web content satisfies all the Level A, Level AA and Level AAA success criteria

Wikidata as a web accessibility knowledge base

Wikidata (Wikimedia Foundation, 2025d) is the database that powers Wikipedia and can also serve as knowledge base of web accessibility. In November 2025, Wikidata ranked nine among the 50 most visited websites in the word (Similarweb, 2025). Wikidata is the world's largest open-source collaborative knowledge graph and contains vast amount of information in different languages (Koutsiana et al., 2023).

In order to raise public awareness of web accessibility, we suggest that researchers adopt strategies similar to those used in commercial advertising and ensure that web accessibility is present in the places where people look for information. Therefore, the hypothesis is that making web accessibility information available on Wikidata and Wikipedia will increase public awareness about the need to improve web accessibility and achieve compliance.

The Web evolves constantly and NL websites need to be tracked periodically by a web accessibility observatory. However, global availability of web accessibility observatory is a pending challenge (Mohamad and Velasco, 2020). On the one hand, it involves human and financial resources that are difficult to stand over long period of time. On the other hand, it should be freely accessible to public. Therefore, by using Wikidata and Wikipedia for monitoring web accessibility of NL websites, we overcome those limitations. Furthermore, as Wikidata is machine-readable, web accessibility information will also be available for machine learning and artificial intelligence (Luth, 2024).

Related work

The web accessibility of libraries' websites and catalogs (Irvall and Skat Nielsen, 2005; Kous et al., 2020; Xie et al., 2026) is a topic that has undergone intensive research using a variety of evaluation methods (Galkute et al., 2020; Jilani et al., 2026; Liu et al., 2024; Panda and Kaur, 2022). Hereafter, we present important papers related that address the web accessibility in libraries and their findings.

Spina (2019) conducted research into web accessibility in libraries against WCAG 2.1. The results showed that many libraries were not compliant, and that commitment was needed to improve the accessibility of their existing web content. This could involve consulting individuals with disabilities during the user experience (UX) design process, for instance.

Panda and Chakravarty (2020) evaluated the web accessibility of the Indian Institute of Technology library against

WCAG 2.1. The results showed that it was not possible to reach conformance levels A, AA and AAA.

Kiruki and Mutula (2021) conducted a study to determine the accessibility and usability of library websites at public universities in Kenya for students with visual and physical impairments. Data were gathered through survey questionnaires, focus group discussions, structured interviews and observation from six universities. The results revealed that people with disabilities were excluded from accessing and using library websites in public universities, and that these universities should evaluate their websites to ensure compliance with the WCAG issued by the W3C.

In 2022, several works were published on the accessibility of public libraries' websites. Khawaja (2023) investigated the accessibility of 120 public library websites in the United States using Deque's Axe as the AWAET. The results showed that public library websites failed to meet WCAG 2.1 requirements by a large margin, with color contrast errors being the most common type of error. Another study was conducted by Panda and Kaur (2022), a systematic literature review (SLR) on the accessibility of library websites. The SLR comprised 40 relevant studies, the results revealed that, regardless of the country, the state of web accessibility on library websites falls significantly short of WCAG compliance. Tiurkedzhy et al. (2022) also conducted a study focused on the accessibility of digital libraries and specialized library resources. A total of 56 libraries were analyzed using web accessibility services and it was found that only three libraries met WCAG 2.1 accessibility requirements, achieving a compliance score of 92%. Also, McCann and Peacock (2021) performed a study focused on common accessibility errors in academic libraries. A total of 124 library homepages were examined using the WAVE web accessibility tool, and a summary of common errors and warnings was compiled. Recommendations were provided for future improvement to address the web accessibility errors identified.

Devi and Kumar (2023) evaluated the accessibility of 15 selected library websites in the Delhi National Capital Region against the WCAG 2.1, using WAVE. They found that 13 out of 15 library websites did not comply, with the most common error being linked images missing alternative text, followed by empty links and empty buttons.

Vance (2024) assessed the digital accessibility of public libraries in Mississippi against the WCAG, using the WAVE. A total of 51 public library systems were evaluated, and the results showed that web accessibility in Mississippi's public libraries is an ongoing issue that requires attention through professional development and raising general awareness of digital accessibility. The study also identified the most common errors as low color contrast, linked images missing alternative text, empty links, and missing form labels.

Campbell-Meier and Velasquez (2025) conducted a study in which they measured the digital accessibility of

New Zealand public libraries using WAVE as AWAET. A total of 66 libraries were evaluated against the and accessibility issues were reported, indicating room for improvement in order to commit to equitable access.

Methodology

This study aims to assess the web accessibility status of NL websites worldwide. It also explores the presence of web accessibility information on NL items on Wikidata and their corresponding webpages on Wikipedia. To achieve these objectives, this study is organized into two phases: evaluating the web accessibility of NL websites and publishing the resulting accessibility information on Wikidata and Wikipedia.

Web accessibility evaluation of national libraries

The following methodology was used to carry out the web accessibility evaluation of the NL websites:

1. Select NLs (Wikimedia Foundation, 2025a) and collect their URLs. NLs that did not have a URL from the list above were searched from Google.
2. Search for selected NLs on Wikidata and get their corresponding QID, which is a unique number used to locate an item from Wikidata.
3. Test the URLs of the NLs to ensure they are online. Any URLs found to be offline was removed from the list. Initially, we identified 124 NL websites. A total of 14 NL websites lacked a functional online URL and were therefore excluded, resulting in a final sample of 110.
4. Select the AWAET that will be used to assess the WCAG 2.2 compliance of selected websites. Pope Tech was chosen as it can crawl and scan all the pages of a list of websites for web accessibility issues (Pope Tech, 2025). Pope Tech is a web accessibility evaluation platform that combines automated scanning, reporting, and monitoring features to support accessibility audits and large-scale compliance assessment in websites according to WCAG. Pope Tech is built on top of the accessibility testing engine provided by WAVE and provides aggregated WAVE results across multiple pages, sites, or domains.
5. Create a group in Pope Tech for NLs and add the URLs of the NL websites to the group. Although Pope Tech allows the bulk import of websites from a file, we opted for manual import as some of the websites could not be read by Pope Tech. After some days, we try adding the websites again to make sure the offline status was not accidental. We

could not determine the reason that some websites were not accepted by Pope Tech; however, we noticed slowness in response when we accessed those websites. Finally, 32 NL websites were dismissed because not readable by Pope Tech, remaining 78 for evaluation.

6. Scan created group of NL websites for web accessibility issues. Pope Tech can scan two different viewports of websites: viewport 1200 for desktop and viewport 500 for mobile. In this study, we focus on the desktop version. Pope Tech was set up to crawl the websites recursively and scan all the webpages for errors. The crawling limit was set at 900 pages. Some NL websites were readable but not scannable by Pope Tech and therefore these were also removed from the sample. Several scans were performed on different days before deciding to remove certain websites. A total of five websites were dismissed because of not being scannable by Pope Tech. At the end, the evaluation sample, as shown on Table 1, is composed by 73 NLs, 11 from Africa, 12 from America, 19 from Asia, 29 from Europe and 2 from Oceania.
7. Create a report schedule in Pope Tech and receive reports via email in CSV format. Table 2 contains items that are reported by Pope Tech.
8. Analyze the results of web accessibility evaluation of NL websites by using the statistical tool named Tableau Public edition 2024 3.4 (Salesforce Inc, 2025).
9. Discuss the results and draw conclusions.

Publishing web accessibility information of national libraries into Wikidata and Wikipedia

The following methodology was used to publish the web accessibility information of NL websites into Wikidata and Wikipedia:

1. Create web accessibility statements and qualifiers for NLs in Wikidata so that the web accessibility attributes for the NL websites can be seen on Wikipedia. The procedure for creating these statements is as follows:
 - (a) First, we searched for NL item on Wikidata by name or by QID.
 - (b) Secondly, we looked for attributes that can be used to create web accessibility information of NLs in Wikidata.
 - (c) Thirdly, we created qualifiers to contextualize the web accessibility information that we provide in Wikidata for NLs.
2. Upload information on the web accessibility of NL entities to the Wikidata database.

Table 1. List of selected nations which national libraries are to be evaluated in this study.

Country	Wikidata QID	Country	Wikidata QID
Albania	Q678964	Montenegro	Q5061489
Algeria	Q2901476	Morocco	Q2901478
Armenia	Q8213985	New Zealand	Q390375
Australia	Q623578	Nicaragua	Q621960
Austria	Q304037	Nigeria	Q6974165
Belgium	Q383931	Norway	Q924551
Bermuda	Q4892643	Oman	Q7636727
Bhutan	Q2602355	Palestine	Q56376819
Bosnia and Herzegovina	Q22780	Panama	Q5727818
Brazil	Q948882	Peru	Q2901492
Bulgaria	Q631641	Philippines	Q1911986
Canada	Q24229358	Portugal	Q245966
China	Q732353	Qatar	Q1361436
Colombia	Q2901472	Romania	Q622012
Costa Rica	Q15548033	Serbia	Q945496
Cuba	Q5728066	Seychelles	Q6974183
Denmark	Q867885	Singapore	Q890364
Eswatini	Q68652876	Slovakia	Q620899
Ethiopia	Q2567785	Slovenia	Q1520466
Finland	Q59783979	Spain	Q750403
France	Q193563	Sri Lanka	Q71153233
Ghana		Srpska	Q12755992
Hong Kong	Q616184	Sweden	Q953058
Hungary	Q1063819	Switzerland	Q201787
Iceland	Q627423	Taiwan	Q618340
Indonesia	Q627102	Tanzania	Q47011220
Israel	Q188915	Thailand	Q618628
Japan	Q6006737	Tunisia	Q606065
Jordan	Q6974152	Turkey	Q4810305
Kenya	Q6974126	Uganda	Q618252
Kosovo	Q856462	Ukraine	Q856462
Lithuania	Q1635759	United Kingdom	Q23308
Luxembourg	Q856651	United State of America	Q131454
Macau	Q10397460	Uruguay	Q3308862
Malawi	Q6974127	Vietnam	Q618661
Malaysia	Q625167	Zimbabwe	Q6974180
Mexico	Q5495070		

Table 2. WAVE tool items present in Pope Tech reports of web accessibility of national libraries.

WAVE tool item	Description
Errors	Web accessibility issues that will impact certain users as failed to meet WCAG criteria
Alerts	Elements that may cause issues to certain users but are in accordance with WCAG criteria. For instance, an image with an alternate text, but too long.
Contrast errors	Text that does not meet WCAG contrast requirements and that may cause issues to persons with visual impairment disability.
ARIA	ARIA elements that are present in the web pages.
Features	Elements that improve accessibility if implemented correctly
Structural	HTML and ARIA regions that highlights hidden elements and nesting

3. Update the Wikipedia pages for the NLs by introducing a section that discusses their web accessibility status.
4. Create a web accessibility monitoring application for the NLs on Wikidata.
5. Discuss the results and draw conclusions.

Step 2 is performed using OpenRefine (2025). The process to achieve step 2 is as follows:

1. First, download and install OpenRefine on a local computer.
2. Second, prepare a special table to be loaded into OpenRefine and the corresponding project. The columns of this special table contains all the elements needed to prepare a statement into Wikidata, which are, the Library name, Test score, Point in time, Object named as, Score method, Named after, Complies with, Depends on, URL reference Pope Tech, URL reference WCAG 2.2, URL reference WebAIM, URL reference of Data (DOI of the dataset in Mendeley Data).
3. Third, conciliate the columns against corresponding Wikidata items and properties in OpenRefine.
4. Fifth, we edit a Wikidata scheme in OpenRefine and prepared the statement of web accessibility information: national library has characteristics of web accessibility.
5. Sixth, we exportd the schema of the statement from OpenRefine into the database of Wikidata.

Results

In this section we present the results of evaluating the web accessibility of NL websites and the publication of related information into Wikidata and Wikipedia. These results were collected by performing the steps described in the methodology section of this research in September 2025. A total of 73 NL websites were evaluated from countries all over the world: 11 from Africa, 12 from America, 19 from Asia, 29 from Europe, and two from Oceania. The complete dataset from which these results are extracted is available online at Mendeley Data repository (citation removed for peer review). The presentation of the results of this study is organized as follows:

- Firstly, we present insights derived from Pope Tech's web accessibility evaluation reports, including a summary report, a page report analysis and a results report analysis of web accessibility barriers. Each area is presented hereby as a subsection focused on the corresponding Pope Tech report type.
- Secondly, we present the results of introducing web accessibility scores for the NL websites into Wikipedia and Wikidata. In this case, we focus on

- (1) creating a web accessibility statement in Wikidata and (2) retrieving web accessibility information from Wikidata.

Results of web accessibility evaluation of national libraries

Pope Tech is a monitoring tool that internally uses WAVE for webpage accessibility evaluation. Pope Tech provides a variety of reports. For this study, three of these reports were selected for analysis. The summary report presents overall web accessibility performance in the form of WAVE tool item values. The page summary report provides a detailed analysis of web accessibility performance of all the web pages belonging to each NL. And finally, the result summary report shows the overall performance of all NL webpages in terms of conformance with WCAG 2.2 success criteria.

Summary report of web accessibility performance of national libraries. Table 3 presents a summary of the web accessibility performance of the NLs of countries around the world. A total of 46,584 webpages of NLs were crawled and scanned by Pope Tech for web accessibility conformance against WCAG 2.2. We observe that the error density and alert density are low, although the number of errors per webpage (32) and alerts per webpage (40) are considerable, even though are not very high.

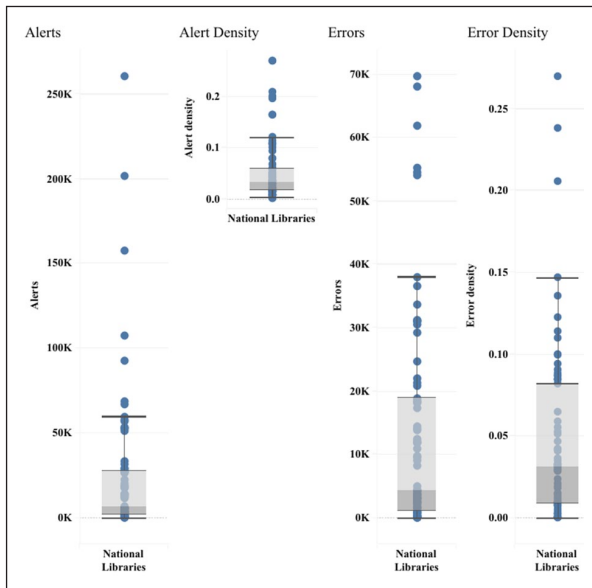
Report analysis for national libraries. This subsection provides an analysis of the web accessibility performance of NL websites and their corresponding webpages, derived from the Pope Tech Page Summary Report. This analysis was conducted by loading the web accessibility data from the report into Tableau Public (Salesforce Inc, 2025).

Concerning alerts and errors, Figure 1 shows the box plot of errors reported from web accessibility evaluation of selected NL websites. We observe that NL websites have a considerable number of errors, although the error density is low. Even though the number of errors per webpage is considerable, the value of the median in the box plot shows that half of NL websites present less than 14 errors per webpage. We also can observe that the number of alerts on NL websites is high, although the alert density is low. The median of alerts per webpage is 9.7, which means that half of NL websites have less than 10 alerts per webpage.

Concerning ARIA, features and structural elements, Figure 2 shows a box plot representing their corresponding performance from NL websites evaluations by Pope Tech. ATS is a score from 1 to 10 based purely on automatic checks that compares measurement from the website to the most recent WebAIM Million (Utah State University, 2026). We observe that NL websites perform very poorly in ATS. We also observe that NL websites contain considerable number of ARIA elements. Concerning the Features

Table 3. Summary of web accessibility for national library reported by Pope Tech.

Property	Value
pages_scanned	46,584
Errors	1,522,220
error_density	0.029793
errors_per_page	32.67688
Alerts	1,889,918
alert_density	0.03699
alerts_per_page	40.57011
Structural	2,702,344
ARIA	5,883,048
Features	1,282,394

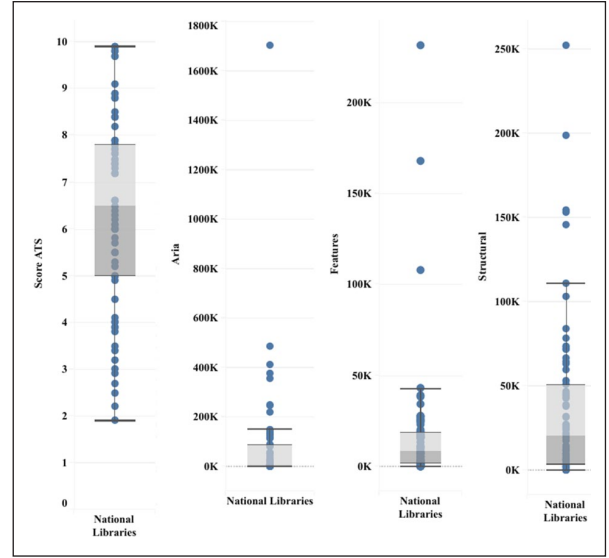
**Figure 1.** Box plots of web accessibility alerts and errors of national libraries.

and Structural elements, the performance is low as the values of their respective medians are high.

Report of web accessibility issues in national libraries. This subsection provides an analysis of the web accessibility performance of NL websites in terms of the conformance level to success criteria of WCAG 2.2. The analysis was conducted by creating a Microsoft Excel table containing data from the result summary report from Pope Tech which was then loaded into Tableau Public (Salesforce Inc, 2025).

Concerning the category of web accessibility barriers, we observe that 1,889,906 violations are just alerts suggesting manual verification. Other 518,152 violations are contrast errors and 485,465 are common errors. We can see that NL websites have more contrast errors than ordinary errors.

Concerning the conformance levels, we observe that NL websites violate 950,158 times the WCAG

**Figure 2.** Box plot of web accessibility scores, ARIA, features and structural elements of national libraries.

conformance level A, 518,152 times the WCAG conformance level AA, and 251,781 times the WCAG conformance level AAA.

Concerning the type of WCAG violations, Table 4 shows the frequency of violated WCAG web accessibility elements. We can see that the top-5 violations are: empty link, missing form label, linked image missing alternative text, empty button, and missing alternative text.

Publishing web accessibility of national libraries into Wikidata

In this subsection, we present the results of publishing web accessibility information into items of NLs in Wikidata and Wikipedia. The process took place in September 2025.

Creating the statements for web accessibility into Wikidata items of national libraries. Information about an item is recorded in Wikidata using statements. A statement comprises an item and a property-value pair. From a linked data perspective, the item is the subject, and the property is the predicate. The statement selected to introduce web accessibility information to an NL item in Wikidata is “has characteristic,” with the property “web accessibility,” meaning that NLs has the characteristic of web accessibility. To contextualize web accessibility scores into NLs on Wikidata, we have to use qualifiers. We have chosen properties that are already into Wikidata as qualifiers to associate to the statements:

- Test score. The score obtained from the evaluation, in a scale of 1–10.
- Point in time. The date of the evaluation, in month and year format.

Table 4. Type of WCAG violations.

Type of WCAG violation	Value
Blinking content	0
Broken ARIA menu	10,685
Broken ARIA reference	28,642
Broken skip link	2920
Empty button	32,584
Empty form label	5060
Empty heading	15,753
Empty link	202,107
Empty table header	615
Image button missing alternative text	4
Image map area missing alternative text	97
Image map missing alternative text	90
Invalid longdesc	19
Language missing or invalid	7883
Linked image missing alternative text	55,487
Markee	65
Missing alternative text	32,170
Missing form label	88,850
Missing or uninformative page title	163
Multiple form label	1823
Page refreshes or redirects	0
Spacer image missing alternative text	448

- Object named as. The name of the test, which is “Automated Accessibility Score.”
- Score method. In this case it is automated by a computer program.
- Named after. The subject or organization that provided the name of the test, which is in this case Pope Tech.
- Complies with. The web accessibility guidelines that the test should comply with.
- Software used as AWAET for the evaluation.

Table 5 presents the Wikidata elements used in the statement representing web accessibility for a NLs, alongside their unique identifiers and category. The statement in Wikidata described as follows: The NLs has a web accessibility characteristic. The value of this statement is the automated test score from Pope Tech.

Figure 3 shows a snapshot of the statement representing the web accessibility of the National Library of Albania (Wikimedia Foundation, 2025b). Its unique identifier on the Wikidata platform is Q678964 and obtained a test score of 8.4.

Publishing into Wikipedia. Once the web accessibility statement and its qualifiers were introduced into Wikidata, the Wikipedia pages of NL websites were updated with a web accessibility section. Figure 4 shows the web accessibility section that was created on the National Library of Australia Wikipedia page (Wikimedia Foundation, 2025c).

Retrieving web accessibly data from national libraries in Wikidata. This subsection presents a proof of concept for a monitoring application (Nso-Mangue and Luján-Mora, 2026) that acts as an observatory for the web accessibility of the NL websites. The application was developed using the Shiny package for the R programming language, and SPARQL Protocol and RDF Query Language. The application queries for accessibility information from the database of Wikidata and presents the results.

Additionally, to demonstrate the capabilities of linked data from Wikidata, the application presents the correlation between ATS scores of NL websites and the Human Development Index (United Nations, 2025), their corresponding country, as well as the population of the countries to which the NLs belong.

As illustrated in Figure 5, the application has three tabs, and the first tab presents a table showing the web accessibility information from NLs from Wikidata. The second and third tabs present a box plot of ATS of the NL websites and correlation between ATS and human development index, respectively.

Discussion

This study aimed to assess the web accessibility status of NL websites around the world. On the one hand, it examined the web accessibility performance of NL websites. On the other hand, it also explored the possibility of including web accessibility information in the items of NLs available on Wikidata so that it becomes a web accessibility knowledge. A total of 73 NLs from different countries were included in this study. The selection criteria was that the NL websites should be online and evaluable on the Pope Tech platform. The evaluation reports provided by Pope Tech were analyzed using Tableau Public, a data visualization and statistical analysis tool.

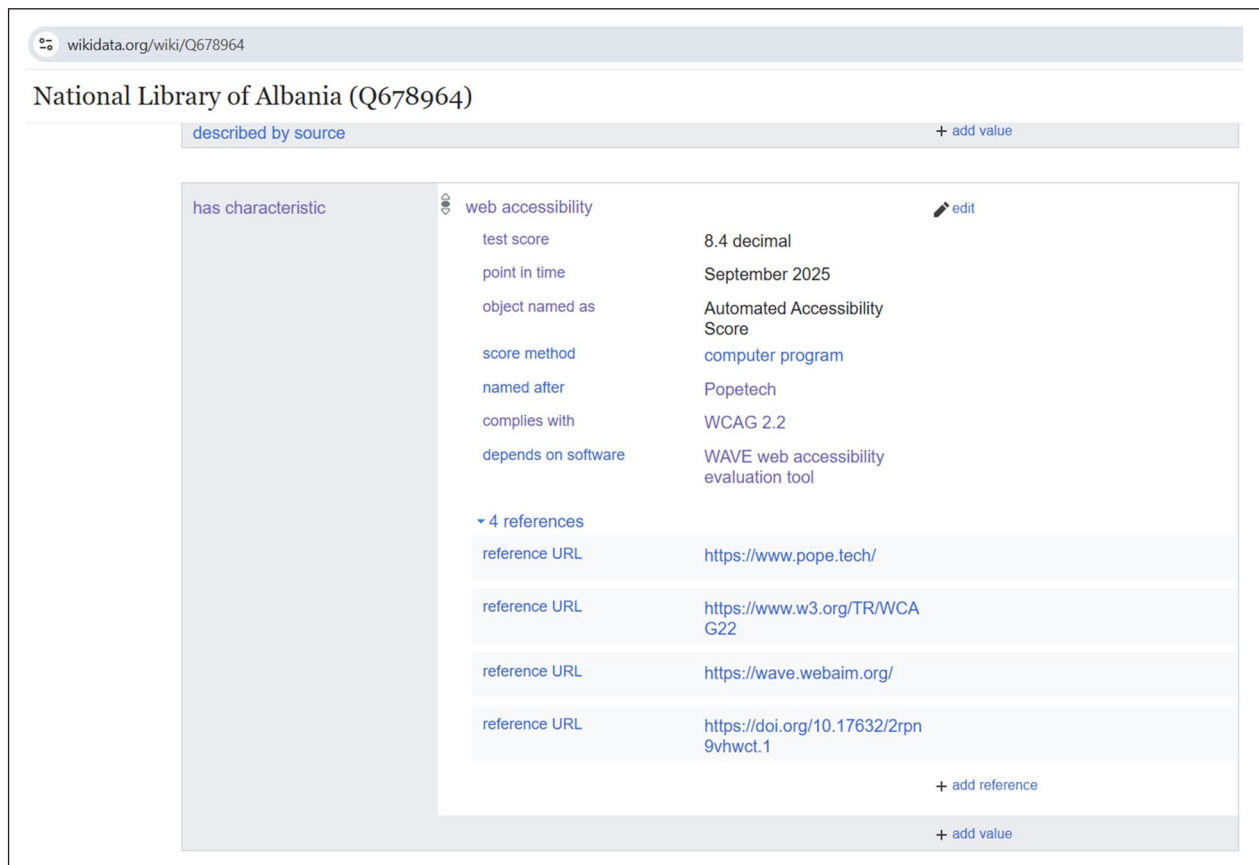
In this section, we discuss the findings of the research in relation to the WCAG principles, success criteria, conformance levels and regulations. We also discuss the findings in relation to the advantages and disadvantages of using Wikidata and Wikipedia as a knowledge base for web accessibility compliance and awareness.

In summary, three important facts can be extracted from the results of this research study:

- Most of NL websites around the world still present barriers to people with disabilities because they scored low on the ATS. NL websites contain errors, alerts, and issues with features and structural elements. However, they also contain a large number of ARIA elements, which make them robust and enable interaction with current and future assistive technologies.
- The top-5 WCAG violations on NLs' websites in this research study are empty links; missing form labels; linked images missing alternative text;

Table 5. Wikidata elements used in this study to reference a web accessibility of a national library in Wikipedia.

Entity	Unique Identifier	Category
National library	Q22806	Item
Web accessibility	Q808932	Property
Test score	P5022	Value
Point in time	P585	Qualifier
Object named as	P1932	Qualifier
Score method	P1443	Qualifier
Named after	P138	Qualifier
Complies with	P5009	Qualifier
Depends on software	P1547	Qualifier



National Library of Albania (Q678964)	
described by source + add value	
has characteristic	web accessibility edit
test score	8.4 decimal
point in time	September 2025
object named as	Automated Accessibility Score
score method	computer program
named after	Popetech
complies with	WCAG 2.2
depends on software	WAVE web accessibility evaluation tool
4 references	
reference URL	https://www.pope.tech/
reference URL	https://www.w3.org/TR/WCA G22
reference URL	https://wave.webaim.org/
reference URL	https://doi.org/10.17632/2rpn 9vhwct.1
+ add reference	
+ add value	

Figure 3. Web accessibility statement inserted into the National Library of Albania in Wikidata.

empty buttons; and missing alternative text. Four of these WCAG violations also appear in the top-6 WCAG violations in a million websites accessibility report from WebAIM (Utah State University, 2026). Therefore, the websites of NLs worldwide have similar web accessibility issues of the majority of websites worldwide.

- The publication of the web accessibility scores of NLs in Wikidata increases their visibility, as Wikidata is the world's largest database. This makes NLs' data available to Wikipedia and to machine learning for artificial intelligence.

Web accessibility evaluation of national libraries

Based on the findings summarized in Table 3, NL websites contain a considerable number of errors and alerts. They also present issues with structural elements and features. However, NL websites perform well in terms of ARIA as they have a considerable number of ARIA elements, which is good in terms of robustness.

Alerts and errors. The errors identified by the WAVE tool in a web accessibility evaluation represent a direct

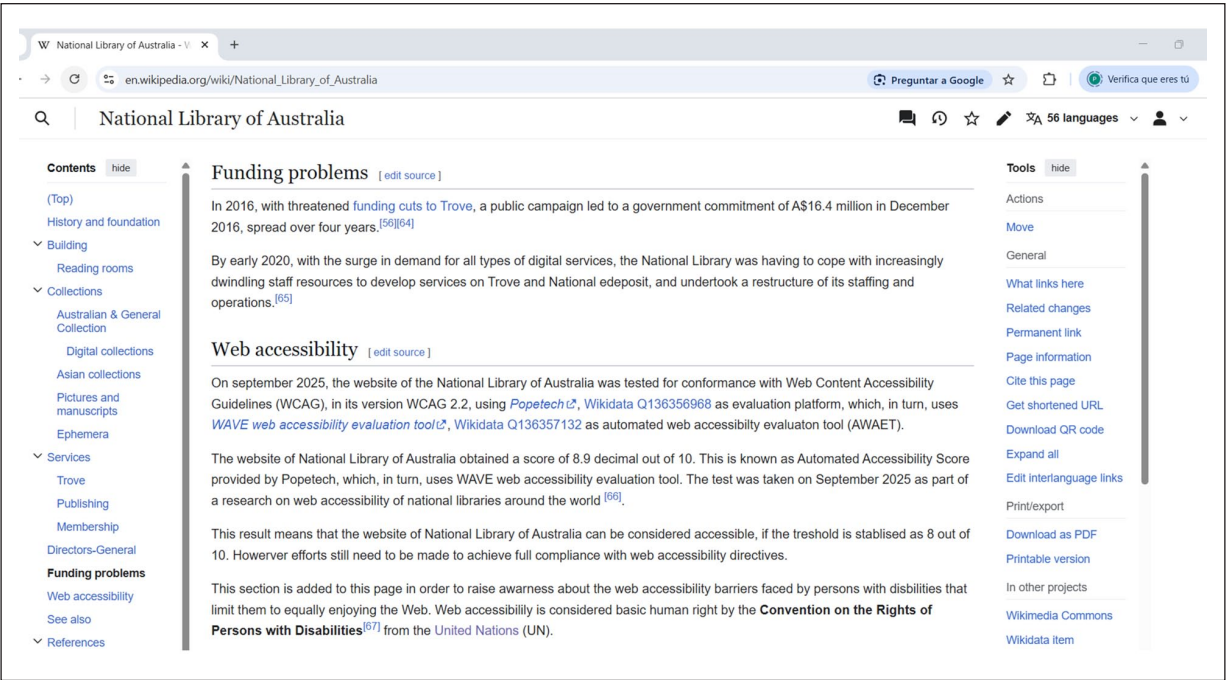


Figure 4. Web accessibility information inserted into the Wikipedia page of the National Library of Australia.

The screenshot shows a Shiny web application interface. On the left, there is a sidebar with information about the 'Automated Accessibility Score' evaluation, including the date (September 2025), method (automated), platform (Popetech), and guidelines (WCAG 2.2). The main area displays a table with 10 columns: library, wacountryLabel, libraryLabel, continentLabel, waLabel, testScore, date, testtssuerLabel, and guidelinesLa. The table contains 7 rows of data, showing the accessibility scores for various national libraries.

library	wacountryLabel	libraryLabel	continentLabel	waLabel	testScore	date	testtssuerLabel	guidelinesLa
1		National Library of Kosovo		web accessibility	5	2025	Popetech	WCAG 2.2
2	Albania	National Library of Albania	Europe	web accessibility	8.4	225	Popetech	WCAG 2.2
3	Algeria	National Library of Algeria	Africa	web accessibility	8.2	2025	Popetech	WCAG 2.2
4	Armenia	National Library of Armenia	Asia	web accessibility	3.5	2025	Popetech	WCAG 2.2
5	Australia	National Library of Australia	Oceania	web accessibility	8.9	2025	Popetech	WCAG 2.2
6	Austria	Austrian National Library	Europe	web accessibility	2.5	2025	Popetech	WCAG 2.2
7	Belgium	Royal Library of Belgium	Europe	web accessibility	8.8	2025	Popetech	WCAG 2.2

Figure 5. Table view with web accessibility information of national libraries extracted from Wikidata.

non-conformance with WCAG directives. As Figure 1 shows, the median error density and error per page on NL websites are low, which means that the overall performance is not so bad.

Alerts from a web accessibility evaluation highlight potential accessibility issues that require manual review to determine whether they constitute actual problems that requires to be fix. As shown in Figure 1, the median value

of alert density of NL websites is low, which indicates that they have fewer issues that should be fixed manually.

Automated testing score, ARIA, features, and structure. NL websites have poor performance in web accessibility as most of the ATS scores are lower than 8, as shown in Figure 2. We have also found that NL websites have considerable number of ARIA elements. Having more ARIA means that NL websites adhere more closely to the WCAG principle of robustness. Therefore, their content can be reliably interpreted by a wide variety of user agents, including current and future assistive technologies (World Wide Web Consortium, 2024a).

In terms of features, Figure 2 also shows that NL websites have considerable number of failures, meaning that they do not satisfy the WCAG principle of operable. Therefore, users may find it more difficult to navigate and interact with NL websites using a keyboard.

In terms of structure, Figure 2 also shows that NL websites again present a lot of barriers to the WCAG principle of understandable. A website is understandable when its content is easy to read and predictable, helping users to avoid and recover from errors (World Wide Web Consortium, 2024a).

Contrast errors. Most of the WCAG non-conformance are contrast errors, which means that persons with visual impairments encounter barriers when accessing NL websites.

WCAG conformance. Considering the conformance level, there are more NL websites that conform with level A, following those that conform with level A and AA. This is the normal behavior in performance, as expected. Conformance level A comprises a minimum set of accessibility barriers that a webpage should not present to be accessed by most of the persons with disabilities. Conformance level AA adds more barriers to satisfy by a webpage, including those at level AA. Conformance level AAA is more demanding to fulfill by a webpage (World Wide Web Consortium, 2023b).

Type of WCAG violations. Table 4 shows that the top-5 most violated WCAG elements are: empty link, missing form label, linked image missing alternative text, empty button, and missing alternative text. These are web accessibility barriers that violate the four WCAG principles: perceivable, operable, understandable and robust. A webpage with empty links is not operable.

Publishing web accessibility of national libraries into Wikidata

Initially, no information about the web accessibility of NL websites could be found on Wikipedia. Therefore, we had

to create a statement and use it to add information of the web accessibility score into NL items on Wikidata. The properties used in the statement and its qualifiers were chosen from those that are already available in Wikidata. However, it would be fine to create specific properties for web accessibility.

To be able to reference Pope Tech from Wikidata, we had to create an item that represent it. We also had to create another item for WAVE.

Having the web accessibility test scores of NL websites in Wikidata facilitates performance monitoring over consecutive years. Additionally, it makes web accessibility information of NL websites to be available as linked data that are available to everyone and artificial intelligence, raising awareness of the web accessibility barriers faced by disabled people.

Limitations

This study has the following limitations:

- In order to prepare a statement representing the web accessibility of NLs in their corresponding Wikidata items, we were limited by the range of available Wikidata properties to be used. Finally, we had to adapt to the items and properties that were already available in Wikidata, as creating new properties and waiting for them to be validated was beyond the scope of this research due to the timeline.
- NL websites may have different web accessibility score values at various points in time. This study does not address the integration challenges that arise from having multiple web accessibility values.
- As part of the knowledge transfer activities associated to with this study, accessibility score was added to Wikipedia entries of the NLs. However these contributions were subsequently removed, likely due to Wikipedia's editorial policies regarding verifiability, sourcing, and the inclusion of original research. This highlights the challenges of disseminating research-derived indicators through collaborative encyclopedic platforms. Wikipedia operates under strict editorial guidelines that prioritize secondary, independently published sources and generally restrict the inclusion of original research or novel metrics. As the accessibility score proposed in this study has not yet been widely cited in external secondary sources, its inclusion in Wikipedia entries proved unsustainable.
- At first glance, the fact that this study uses only one AWAET for evaluation appears to limit the reliability of the scores it provides. However, the ATS score is a complex measure that considers the performance of millions of websites from a variety of

business sectors. This is why it was selected for this research study. Nevertheless, it is well known that AWAETs cover at most 40% of WCAG (Fischer et al., 2025) success criteria and that different AWAETs provide different scores for the same website or webpage. In this case, using more than one AWAET may increase the coverage and completeness, but may also increase false positives which reduce the correctness. Additionally, a combination of automated and manual evaluations provides even greater reliable results.

Conclusions and future work

Conclusions

This study aimed to examine the web accessibility performance of NLs. It also added information on the web accessibility scores of the NLs to Wikidata for the first time.

The web accessibility evaluation of NLs was carried out by using the Pope Tech platform. A total of 46,584 webpages selected from NL websites were scanned by Pope Tech, whose reports were later analyzed using Tableau Public, a statistical and data visualization tool.

Although a great majority of selected NLs are from countries that have signed and ratified the CRPD (United Nations, 2006), the results showed that NL websites are not in conformance with WCAG 2.2 (World Wide Web Consortium, 2024b). NL websites scored low on ATS and presented several web accessibility errors, contrast errors, issues with structural elements and features that pose barriers to persons with disabilities. However, NL websites used large numbers of ARIA elements, which supports compatibility with assistive technologies, such as screen readers, braille displays and others.

In relation to publishing web accessibility scores of NLs into Wikidata, we found that NL items lacked web accessibility statements and we created one for each NL item. This statement was enriched with qualifiers to provide context for the web accessibility evaluation from which the scores were obtained.

Having web accessibility information on Wikidata has some advantages, as it is a linked database that allows association of different parameters that can be correlated. Also, by making web accessibility information available in Wikidata, we ensure that it is preserved and accessible worldwide for future studies, including machine learning. As Wikidata powers Wikipedia, the availability of web accessibility information of NLs on Wikidata may help to reach larger audiences to raise awareness to potential stakeholders.

The subsequent removal of the information about web accessibility of NL websites from Wikipedia pages reflects the current stage of dissemination of this kind of information, which is still undergoing academic validation and has not yet been adopted or referenced

by independent authoritative sources. This experience illustrates the tension between open collaborative knowledge platforms and the integration of emerging research outputs. This is particularly evident in areas such as web accessibility, where standardized and widely accepted indicators are still evolving.

In summary, NLs play a substantial role in providing access to books, manuscripts and digital records related to cultural and intellectual heritage of a nation to present and future generations. Therefore, full compliance of their websites with WCAG will allow persons with disabilities to equally enjoy the web. By doing so, NLs will also comply with CRPD and the Sustainable Development Goal number 10 (United Nations, 2015), which aim to reduce inequalities. But, for NL websites to conform with WCAG worldwide, there is a need for commitment from countries in terms of laws, regulations, policies and programs (Global Initiative for Inclusive ICTs, 2020).

Future work

This study could be extended by incorporating additional NL websites not currently included. It could also include websites from other organizations that are already present on Wikidata.

Furthermore, Quarto (2025), a technical publishing system, could help the web accessibility monitoring application to be published as a static website.

Another way to extend this study would be to incorporate more web accessibility variables into Wikidata, such as error density, alert density, and number of ARIA features.

ORCID iDs

Pastor Nso-Mangue  <https://orcid.org/0000-0003-0143-2481>

Sergio Luján-Mora  <https://orcid.org/0000-0001-5000-864X>

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Author biographies

Pastor Nso-Mangue is currently pursuing the Ph.D. degree in computer science with the University of Alicante. He collaborates as a reviewer of scientific articles for several conferences and the journal “Universal Access in the Information Society”. He has also published papers at conference proceedings and journals: Universal Access in the Information Society and IEEE Access. Two of its publications are indexed in Web of Science and Scopus. He has also presented the research results at international conferences. His research interest focus mainly on web accessibility for persons with disabilities.

Sergio Luján-Mora received the Computer Science and Engineering degree from the University of Alicante, Spain, in 1998, and the Ph.D. degree in computer engineering from the Department of Software and Computing Systems, University of Alicante, in 2005. He is currently a Senior Lecturer with the Department of Software and Computing Systems, University of Alicante. In recent years, he has focused on E-learning, massive open online courses (MOOCs), open educational resources (OERs), and the accessibility of video games. He is the author of several books, many published articles in various conferences, including ER, UML, and DOLAP, and high-impact journals, including DKE, JCIS, JDBM, JECR, JIS, JWE, IJEE, and UAIS. His main research interests include web applications and web development, and web accessibility and usability.